Possibilities of Waste Derived Fuel Use in the Energy Sector in Poland

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1. Waste-based fuel use in Poland

According to the National Waste Management Plan [6], mechanical-biological treatment (MBT) of waste is (or will be) preferred in the regions covering over 120,000 inhabitants [9]. It should be highlighted that MBT installations are not dedicated for the final management of waste. Their main purpose is to prepare the waste for the further recovery or disposal.

In Poland, in point of fact the only recipient of refuse derived fuel (RDF) are cement plants. In the power plants and combined heat and power plants, the RDF is not used. The obstacle is formal and legal requirements established for the process of incineration/co-incineration of waste, emission of pollutants and the possibility of adverse changes in ash parameters [3, 8].

It is estimated that Polish cement plants use approximately 1 million tonnes of waste-based fuels per year and can increase this amount by approximately 400,000 tonnes [4]. Possibilities for co-combustion of waste in this sector are limited. Cement plants will not be able to manage all the waste-based fuels produced in the country.

It is worth to mention, that the cement production peak occur in the summer, which causes the significant RDF demand reduction in the winter, when the cement plants work with the partial loads.

Basing on the facts presented above it can be claimed, that the part of the RDF producers will not be able to sell all produced waste-based fuel, unless the possibility of its use in the other sectors, like heat and/or power generation will be created.

Currently, there are 157 MBT installations in Poland with the total capacity of 10,999,100 tonnes per year. Ultimately, till 2020 additional 22 installations are to be operated, it if gives 179 in total, which would be the most in Europe.

In mechanical and biological treatment (MBT) installations the fractions suitable for whole or partial energy recovery are separated from mixed municipal waste. According to [5], the production potential of the Refuse Derived Fuel in Poland equals from 4.5 up to 6 million t/year. The program of building the incineration of mixed municipal waste in the country will not solve all problems related to the waste management. Thermal transformation of waste-based fuels should be carried out in cement plants and power installations. The lack of these types of installations will make it impossible to use the production potential of the MBT plant and, as a consequence, will make the entire waste disposal program incomplete.

In the Polish coal combustion installations, including the power plants, large-scale attempts to co-incinerate waste, including municipal waste, have not been undertaken so far – unlike the German, Dutch or Swedish electricity production systems.

There are several reasons for this conjuncture:

- The requirements for conducting a waste thermal treatment process, in which the conditions of the process are specified. They turn out to be difficult to meet in energy installations;
- Lack of motivation in energy sector enterprises to undertake adaptation of waste co-incineration installations due to the fear of increasing costs and difficulties in obtaining relevant administrative decisions;
- Regulations preventing the co-combustion of waste in installations where there were no technical obstacles (e.g. provisions in the Transitional National Plan);
- Lack of tradition, social acceptance, lack of conviction of decision-makers, including representatives of administrative bodies to support such initiatives

In Poland, the hard coal and lignite remain the dominant sources of energy for electricity production. Total energy production from these sources exceeds 80 % (bez spacji) of the total electricity production.

2. Refuse-derived fuel from municipal waste – basic information

Not all fractions of the municipal waste stream may be intended for combustion in the form of an refuse-derived fuel. Part of them, in accordance with the commonly accepted waste processing technology (MBT), is separated by screening in trammel screen as the subscreen. It is a fraction composed of small elements with a high content of biodegradable parts. Another part of the waste is separated from the main stream in the form of raw materials such as: paper, plastics, etc. Unused part of the waste is a substrate for the production of waste-based fuel or directly this fuel. It should be assumed that the input for the production of waste-based fuels is the mixed municipal waste containing contaminated waste paper and plastics (unsuitable for recycling). An overview of the MBT installation is presented in the Figure 1.

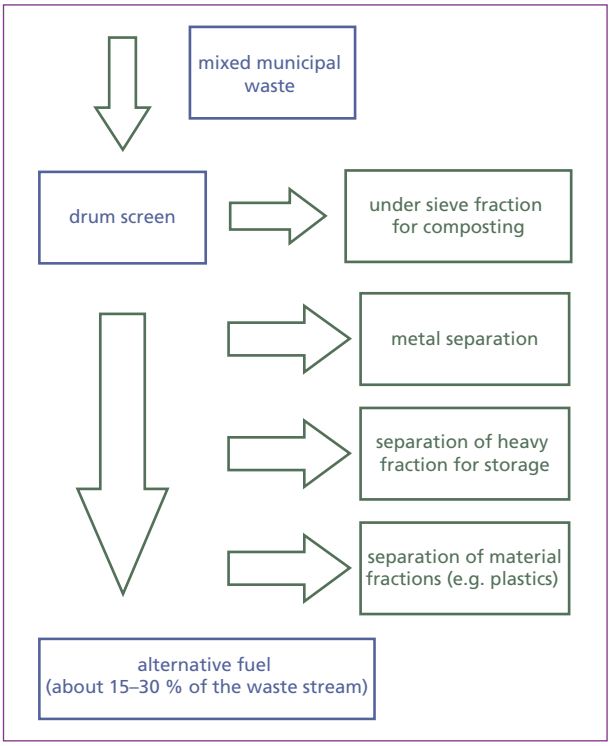

Figure 1:

Schematic diagram of the MBT installation

The process of the waste-based fuel production in all sorting installations (MBT) consists of the following operations:

- sorting;
- grinding;
- metal separation;
- packaging.

Figure 2: Mixed municipal waste

Figure 3: Subscreen fraction of the municipal waste

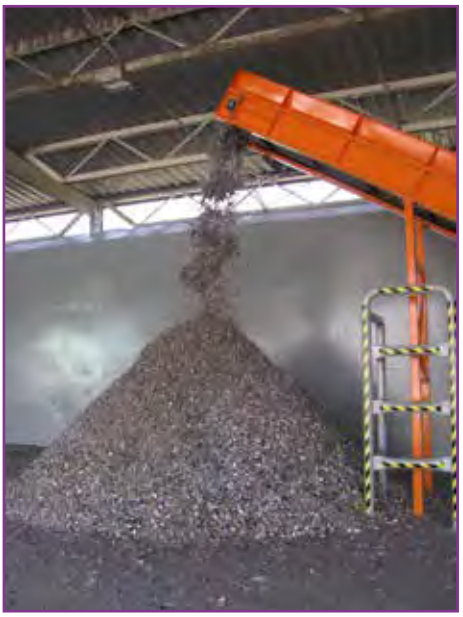

Figure 4: Refuse derived fuel from municipal waste after crushing

Refuse derived fuel generally consists of the following fractions:

- paper,
- plastics,
- composite materials,
- wood,
- textiles.

Due to the Polish law the RDF produced from municipal waste code is 191210. This means that its use must be carried out in accordance with the regulations on thermal treatment of waste [2, 7].

Selected examples of a fuel produced on the basis of mixed municipal waste are summarized in Table 1.

Table 1: Selected parameters of a fuel produced on the basis of the mixed municipal waste

Kind of waste	Code	Signature				
		Calorific value	Sulphur	Chlorine	Humidity	Ash
		MJ/kg	%	%	%	%
RDF	19 12 10	25.16	0.09	0.261	12.89	7.28
RDF	19 12 10	20.20	0.85	< 0.5	14.50	< 8.5
RDF	19 12 10	18.30	0.25	0.590	17.60	13.5
RDF	19 12 10	22.46	0.19	0.23	16.90	14.2
RDF	19 12 10	15.54	0.32	0.22	19.40	9.2
RDF	19 12 10	25.23	0.29	0.58	16.20	28.5
RDF	19 12 10	19.10	0.39	0.52	23.60	10.6
RDF	19 12 10	17.48	0.15	0.32	15.90	8.3

3. Power industry as a partner of local governments in waste management

According to the authors, the huge potential of the electricity and heat production in cooperation with local governments in the field of municipal waste management should be noticed. Cooperation in this area takes place in such an European Union countries as Germany or Sweden. In Germany, many installations with a total capacity of 27 GW have been adapted to co-incinerate municipal waste. German waste incinerators

are currently loaded at only 50 to 80 % (bez spacji), and the power industry does not fully use its potential. RDF is even being imported from Poland to Germany, although due to the transport costs – on a limited scale.

The Janschwalde power plant is the one of the power plants in which co-combustion of waste-based fuels and lignite is carried out. The plant consists of six blocks at the power of 500 MW_e,which gives the total capacity of 3,000 MW_e. The basic fuel is lignite, which comsumption equals to approximately 2,300 tonnes per day.

In the region of Lusatia, lignite mining is carried out by five mines supplying four power plants. In all of them the thermal transformation of waste-based fuels takes place. Co-combustion of such fuels with lignite on an industrial scale has been carried out at Janschwale since 2005.

In 2012, 495,000 tonnes of RDF was co-burned, which corresponds to 3.5 % (bez spacji) of the chemical energy provided in the burned fuel. The waste-based fuel used in the process is mostly produced from the mixed municipal waste.

Co-firing did not result in the reconstruction of the flue gas cleaning installation. It was required to install additional equipment to monitor the emission of gaseous pollutants – such as for waste incineration plants. Waste-based fuel is transported to the plant by road transport.

Infrastructure installations built for the needs of waste-based fuel management are two RDF warehouses. In the halls, the following operations are carried out:

- unloading (to underground bunkers) of the fuel transported by the dump cars;
- gathering the fuel accumulated in bunkers to bunkers located above the conveyors transporting the coal to the boilers.

Waste-based fuel is poured onto a layer of the coal transported by the conveyors to the near boiler bunkers.

The expenditures for the power plant converting to the co-firing RDF installation amounted to approximately 30 million EUR and were intended primarily for the construction of RDF warehouses with associated facilities (including deodorization) and emission monitoring installations.

It seems that also in Poland the benefits of co-firing fuels from waste in fuel combustion installations could be very large:

- power or heating plants would improve the CO_2 emissions balance by reducing the coal consumption and substituting it with the fuels obtained from waste;
- power or heating plants would be able to reduce the cost of fuel, which could be partially replaced by the RDF, which counting on GJ of energy is from three (brown coal) to five times (hard coal) cheaper;
- local governments would save a part of the funds they would have to spend on waste management installations and on the construction or extension of landfills. Those of them, which intended to build incinerators could give up the costly and controversial social investment by directing part of the waste stream to a nearby power or heating plant;

- power stations or heating plants, which in local communities are usually perceived as being a significant nuisance, could improve their image by providing waste management services and reducing the cost of this economy for households.

However, as previously mentioned, in Polish coal combustion installations, no attempts have been made to co-incinerate municipal waste on a larger scale.

Previous studies and analyzes prompted their authors to express their opinion that co-firing of waste-based fuels received from solid waste is unprofitable and is not possible in the current legal order in Poland.

4. Fuel from waste – an alternative approach

The energy use of the waste would be possible to popularize at a radical reduction in the costs of running this process if the fuel generated from them could not have the status of waste. However, the question which has to be faced is if it is possible to create such a fuel and carry out the procedure of losing its waste status.

The Waste Act [10] (Polish Law) in Article 14 § 1 defines the mechanism leading to the loss of waste status by a given object or substance. Due to this procedure, specific types of waste cease to be waste when subjected to a recovery process, including recycling, and meet strict criteria, including criterion (d) *the use of an object or substance does not lead to adverse effects on life, human health or the environment*.

A literal confirmation of no harmfulness of fuel from waste is impossible. It is due to the fact that at the present moment, substances whose incineration *does not lead to negative effects on life, human health or the environment*, even to a minimal extent, are not known. It should be emphasized that this statement refers not only to fuels from waste but also to any other currently used fuel. Therefore, it is necessary to determine the threshold of environmental nuisance at which we *consider* the fuel to be harmless to the environment. Such a point can be defined as, for example the ecological impact of the lignite burning [1].

In the other words, it can be assumed that in order to waste fuel to be deprived of the waste status it must meet environmental criteria, including indicators of environmental nuisance for human health and life determined by, for example lignite, which is after all allowed for the combustion as fuel.

The environmental onerousness of a given fuel depends, among the others, on its chemical composition. However, the legislator neither did specify precisely chemical compounds which should be given a special attention nor what should be the contents of these compounds, in order to be able to confirm the fulfillment of the above condition of the procedure.

The results of the research carried out by the authors showed that the fuel composed of selected waste fractions may show a comparable or even smaller negative impact on the environment, including toxicity for the living organisms, from traditional fossil fuels during combustion in the installation with accepted parameters – including

configuration exhaust gas purification installation. These results may therefore, constitute an argument in the discussion on the validity and possible loss of waste status by fuel produced on the basis of municipal waste in view of fulfilling the previously mentioned condition *d* of the waste disposal procedure specified in the Waste Act.

What is more, the technical equipment of the modern waste sorting plants allows for the deep and very conscious sorting of waste. According to the research results, the waste fuels should maximize the share of four fractions: waste paper, textiles, wood and plastics, excluding PVC (Figure 5).

Figure 5:

Separated factions of mixed municipal waste: 1 – waste paper; 2 – wood; 3 – textiles; 5 – plastics

The described challenge was also dealt with by the others. The case of the Dutch company Icopower can be called here. The Icopower B.V. collects waste from the retail chains, which mainly consists of paper, cardboard, raw wood, plastics, textiles with the possibility of food waste, glass and metal packaging. As a result of preliminary sorting, grinding and removal of ferrous metals, drying and subsequent screening of non-flammable fraction and homogenization, pellets from mixed waste are produced for the energy purposes. In June 2001, the Dutch Ministry of Construction, Spatial Planning and Environment (MINVROM) made an administrative decision against the export of 40,000 tonnes of this material to Söderenergia AB in Sweden, resulting in Icopower B.V. appealing to the Dutch State Council (Raad van State).

The Dutch Council of State has ruled that the fact that the material after processing is equivalent to the basic raw material, has the same properties and can be used in the same way as the basic raw material may be a reason to state that the material is not a waste.

The court noted that the pellets were produced solely for the purpose of using them as a fuel that could be used in the same way as a normal fuel without additional environmental protection measures. On this basis, it was concluded that the energy pellets *were equivalent to normal fuel*. This ruling of the Dutch Council of State was commented on in the legal literature. The comments emphasized that the sentence is in line with the goal of encouraging the recovery of the raw materials from waste and their use instead of natural resources. Pellets are a separate product with a commercial value and can be used in the same way as original fuel with no worse environmental effects.

5. Summary

Legal regulations concerning waste management impose on the entities participating in this segment of the economy obligations that reduce storage in favor of the other forms of their management. The preferred directions are material and energy recovery. The quantitative potential of fuels generated from mixed municipal waste in Poland is estimated at 4.5 to even 6 million tonnes per year. Currently, the only recipients of this type of fuel in our country are cement plants. Their ability of an waste-based fuel consumption is insufficient in comparison with the fuel production potential. The integration of the thermal waste utilization system with the energy and heat generation could make the whole system more complete. Unfortunately, these industries face many problems of a formal and economic nature.

It should be remembered that the necessary increase in material recycling, which is planned in the next years in accordance with European Union regulations, should reduce the amount of waste-based fuel production (the combustible fraction of waste). However it seems, that the waste-based fuel oversupply will continue over the next years.

One of the possible ways out of this situation, in view of the limitations resulting from the legal state in force in our country and the lack of interest in the co-burning of waste in the energy sector, is to use the procedure leading to the loss of waste status. In this situation, it seems necessary to formalize this procedure for this type of waste. This seems to be a very difficult task. However, examples from the other European countries show that certain moves in this area are possible. This path has been followed by some EU countries, for example Austria or Italy, where legal acts allowing this procedure to be carried out have been introduced.

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